

The Place For Heat Reclamation From Incineration

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INTRODUCTION

I have been asked to comment on the potential of heat reclamation from the incineration of solid waste, present and future. I would like to begin by outlining potential usages for heat produced in this type of facility.

POTENTIAL USES FOR WASTE HEAT

Perhaps the most obvious and often cited potential uses for waste heat from incineration, especially in this country, is generation of steam for use in power production. It is unfortunate that we in the U.S. have become so narrow in our thinking in this respect. Many other potential uses for this waste heat are, or could be, developed. Some of these uses are almost as apparent as the steam-power production use while others, to be of any consequence in this country, will probably require some degree of governmental regulation and imaginative leadership.

Where it is contemplated to use this waste heat in the power production process, it is my feeling that electric generating facilities should not be included at the incinerator plant except, perhaps, to produce sufficient power to operate the incinerator. Other potential uses for this heat in the production of commercial power are: feedwater heating; pre-heating of combustion air; and production of highly

purified feedwater makeup by distillation for the power boiler. These uses would free the main cycle steam almost entirely for power production, thus increasing efficiency of this process.

Another potential use for this waste heat is process steam for industrial plants or complexes. A similar use would be for district heating (steam or hot water) and, for year-round use, district cooling. These uses have been developed, on a relatively small scale, on this continent in industrial complexes and for nearby municipally managed complexes. In Europe, where district heating of residential areas and municipal facilities is more prevalent, beneficial use of the heat produced in incinerators is more widespread.

Other potential uses for the heat generated in the incineration of solid wastes includes processing of liquid wastes and production of potable water in an overall municipal complex. While potable quality water has been produced at one plant, and several incinerators are utilized to dispose of the solids generated in the treatment of liquid wastes, no large scale coordinated approach to the provision of these essential municipal services has been attempted to my knowledge.

With some imagination, latitude to engineer a proper economical solution to a particular local problem, and adequate financial backing, these and other uses for waste heat will be developed in the future.

PRESENT TECHNICAL PROBLEMS

With the attractive features of making beneficial use of waste heat, why hasn't there been more development in this area? At least a part of the reason is technical problems that have developed in this application of boilers over the past several years. Some of these problems are briefly outlined below.

EROSION

There is no doubt that erosion has been a factor in the wastage experienced in certain portions of the boilers at some plants. Over the past several years, we have seen the limiting velocities cited for application of waste heat boilers to refuse incinerators gradually decrease from 50 fps to 20 fps, to 11.5 fps, depending on where in the boiler the velocities are being considered. Such low limiting velocities result in greatly increasing the size of these boilers and make it imperative to have nearly ideal gas flow conditions in the boilers. It also makes it imperative to derate the boiler furnaces when the heat content of the refuse rises to the extent that gas volumes passed through the boiler exceed safe limits.

CORROSION — LOW TEMPERATURE

This form of corrosion is fairly well understood and the limits at which attack is most severe are fairly well accepted. This attack has apparently been encountered in some incinerator waste heat installations.

CORROSION — HIGH TEMPERATURE

There are three basic causes of this type of corrosion as reported in the literature. These causes are:

- 1) existence of a reducing atmosphere, or perhaps more correctly alternate reducing-oxidizing atmospheres, in specific regions of the furnace;
- 2) sulfur compounds in the flue gases and fly ash;
- 3) chlorine compounds in the flue gases and fly ash.

Even though substantial excess air levels are presently normally used when burning refuse in waste heat boilers, it has been extremely difficult to avoid areas of oxygen deficiency, or reducing atmospheres, in many of the existing plants. Problems of metal loss due to apparent areas of reducing atmospheres, or alternate reducing-oxidizing atmospheres, have been reported largely

on the tubes along the grate line and the lower water wall sections of the boilers.

It has been considered doubtful that sulfur was a major contributor to metal loss due to corrosion in incinerator waste heat boilers since U.S. refuse contains relatively small amounts of sulfur. However, some investigators do not agree with this over-simplified conclusion. Thus, studies by Battelle and others indicate that sulfur compounds may concentrate in deposits on tubes reaching levels that may contribute to metal wastage.

Most current comment relates tube metal loss to halogens, particularly chlorine, in the refuse, and so in the flue gases. This corrosive action is highly temperature dependent and is affected by both the composition and character of the tube fireside deposits and the composition of the flue gases. Corrosive attack attributed to the halogens and tube deposits has been reported in the superheaters and the convection sections of incinerator waste heat boilers. Tube metal temperature levels at which this attack has been reported have varied from 500°F and up. The composition of both the deposits and flue gases are largely dependent on the refuse composition and variability. This presents an interesting design challenge.

CONTROL OF METAL WASTAGE

The control of metal loss due to erosion or erosion related phenomena can be accomplished by severely limiting maximum velocities in incinerator waste heat boilers and by achieving as nearly as possible, ideal gas flow conditions. This latter criteria can best be evaluated by use of water table tests of proposed boiler configurations.

Various measures have been used to control corrosive attack in the different areas of the boilers. The tubes along the grate line and the lower water wall sections have been coated with refractory or a silicon carbide with good success. Excess air levels have been significantly increased from the 50 percent used in the original "modern" plants (those built around 1963 - 1965). Minimum levels cited in present plants are 70 percent to 80 percent, while some European operators are talking of excess air levels as high as 150 percent, especially in view of continuing increases in refuse heat content. In addition to increasing excess air levels it is necessary to achieve maximum turbulence in the primary combustion zone by properly locating overfire air nozzles and by arriving at an optimum furnace configuration.

A number of approaches have been used to protect the convection surface of these boilers. First, the tubes have been protected through the use of metal shields or the use of refractory or ceramic type of coatings. Furnaces have been derated to keep velocities within acceptable limits. Configurations of existing furnaces have been altered to achieve better flow patterns.

Other methods cited by various authors for achieving a degree of control over metal wastage in incinerator waste heat boilers include:

- 1) achieving better control over mixing of the refuse prior to charging and exercising control over the rate of feed into the furnace;
- 2) use of air curtains on endangered areas of the heating surfaces;
- 3) limitation of steam (and so tube metal) temperatures.

SUMMARY OF PRESENT STATUS

1) An engineered design implies the selection of the most suitable equipment for a process at the lowest possible price to achieve the level of availability, maintenance and operation desired. It is impossible, at present, to achieve *all* of these criteria in the selection of waste heat boilers for refuse incinerators in view of the uncertainty as to corrosion temperature limits, mechanism of attack, and variation of refuse composition. Thus, when a boiler is considered for these facilities, all design criteria must be selected on an extremely conservative basis resulting in an expensive installation. I question the desirability of building many full scale plants until we have obtained enough information from existing installations to achieve a properly engineered design.

2) The application of waste heat boilers to an incinerator built to solve a waste disposal problem requires a sophistication of operation that we have achieved in few, if any, American plants to date. I feel that the people controlling the budgets for refuse disposal operations do not realize the implications of this approach from the standpoint of quality of operating personnel required and the cost of this manpower. Initially this realization was not universal even in the plants incorporating these facilities in Europe. Where suitable personnel were not originally used in these plants, the plants experienced extreme difficulties in overcoming operating problems.

3) Observations made in this country and in Europe, recognition of the differences in heat content and constituents in refuse, and realization of the deficiencies and uncertainties in our present

knowledge regarding this application of waste heat boilers, indicates to me that any plant of this type built here or anywhere else in the world in the near future should include realistic, substantial sums of money in the recommended operating budget for maintenance of the boiler and for conducting possible investigative programs.

There are several factors which, when considered with the inherent desirability of this method of refuse disposal, point to the need to initiate a major investigative program in this area of boiler tube wastage as soon as possible. Thus, the conservative basis of current design criteria set to limit the possibility of experiencing high maintenance costs, results in high first cost of these units. A general benefit would be derived from the development of a better understanding of the underlying causes of the problems currently experienced in incinerator waste heat boiler plants in making available a more economical, conservation oriented, pollution minimizing solution to the rapidly worsening solid waste problem. Because of the general nature of the problem, and benefit from the solution, it is my feeling that this investigative program should be funded by some central agency, rather than looking to individual clients or companies to underwrite the cost of such a program. The initial phase of such a program was initiated in 1969, financed by the Federal Government. This effort should be expanded and pursued rapidly to completion.

FUTURE STATUS OF HEAT RECLAMATION

In my opinion, sometime in the foreseeable future, most municipal refuse from heavily urbanized areas will be disposed of in incinerators with waste heat boilers. This is based on the overall desirability of salvaging the heat generated in this disposal process, improvements in methods of controlling metal wastage, together with the increasing public concern regarding air pollution and the proven performance of the electrofilter in this type of application for removal of dry particulates.

Several considerations are involved in this opinion. First, local authorities responsible for operating these facilities must realize the necessity to hire, pay, train, and retain the calibre of staff personnel required to properly maintain and operate these facilities. Ultimately, if properly staffed, such facilities can probably be operated at less net cost than the present refractory-walled plants.

Second, consideration of ultimate use for the heat generated in these plants should be broadened

to include use in industrial processing, district heating (steam and hot water), and use in complementary municipal functions, in addition to use in power generation. Even integration or use in a power generation facility can be accomplished in a number of ways.

Many of the limitations cited in the past for the application of refuse fired waste heat boilers are as much a result of

- 1) inadequate investigation of the numerous potentials for beneficial use of the waste heat;
- 2) inadequate planning for the use of the waste heat; or
- 3) a function of political or other non-engineering related considerations; as they are of technical problems or limitations.

Solution of the two problems of solid waste disposal and air pollution control, particularly in our heavily urbanized areas, may require a reordering of our priorities and approaches in the disposal of solid wastes, generation of electricity, and heating

of private residences. Thus, a proper technical coordination of the solution to these three problems would result in an answer with minimum impact on the environment. Whether or not such a solution is achievable is at least as much a function of political, business, and economic considerations, as it is of technical considerations.

CONCLUSION

Increasing use of refuse fired waste heat boilers will develop in the future as proper solutions to present technical problems are developed

- 1) by research programs such as that presently underway, at Battelle;
- 2) as proper priorities are established for the solution of our total environmental problems; and
- 3) as other nontechnical problems are answered by a cooperative effort from engineers, businessmen, economists, and politicians to arrive at the best overall solution and implement it through imaginative, dedicated leadership.